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Wright-Patterson Air Force Base, Ohio

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13. ABSTRACT

Some organosilicate compns., used as coatings for the reinforcement elements to form an interlayer between the elements and the concrete material in the prestressed concrete structures, are better than others generally used. The coatings used allow the application of the electrothermal prestressing process requiring a temp. of 300-400°C or the steam-curing of concrete, and provide a good, long-lasting anticorrosive protection. The compns., in form of fine suspensions of silicates and oxides in toluene solns. of polyorganosiloxanes VN-30 (STU-30-2943-66) and C 2 (TU 17-69), viscosity 20-5 sec on the VZ-4 scale, were spread on the reinforcing elements in 3 layers, and dried 30-40 min at 10-20° to produce a 0.3-1.0 mm thick coating. The elements, steel bars or strings, were used inside straight or curvilinear concrete products like blocks, slabs, or beams. A good strength, carrying capacity, and a lack of cracks were noted in the concrete products thus obtained.
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В в	*В в*	V, v	Т т	*Т т*	T, t
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О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

* ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

ORGANOSILICATE MATERIALS IN PRESTRESSED REINFORCED-CONCRETE STRUCTURES

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One of the ways of solving the problem of tension on the concrete from high-strength rod and wire reinformcement for any arrangement and configuration of it is the use of the electrothermal (or electrothermomechanical) method of making prestressed structures [1]. The essence of these methods consists in the fact that prior to concreting the reinforcement is covered with a layer of dressing to get an interlayer between the reinformcement and the concrete. Then the element is covered with concrete with no stress in the steel. After the concrete sets the reinforcement is heated by a high-strength low-voltage electric current for 2-3 min to 300-400°C. In this case, thanks to the presence of the interlayer, the reinforcement is freely elongated in the body of the article. In the elongated state the reinforcement is fixed to the surface of the concrete by permanent anchors. During cooling the reinforcement returns to its initial dimensions, creating the necessary compression of the structure. The

electrothermal method employs the effect of elongating the steel only from electric heating; the electrothermomechanical method uses a combination of heating and subsequent drawing-out of the reinforcement by prestressing jacks to the calculated elongation (Fig. 1).

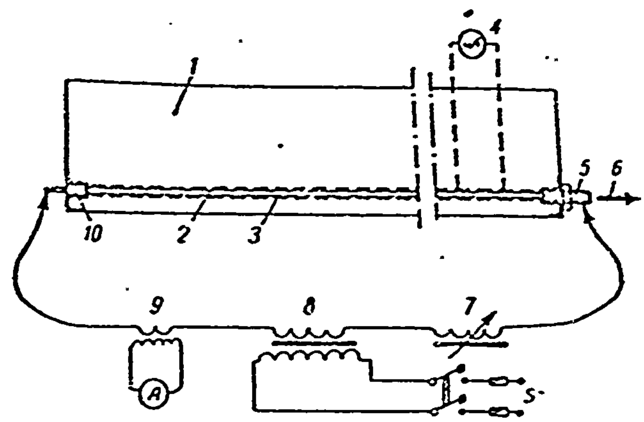

Fig. 1. Diagram of the electrothermomechanical method of stretching the concrete reinforcement: 1 - the reinforced-concrete element; 2 - beam, strand or rod; 3 - interlayer of organosilicate material; 4 - pyrometric galvanometer; 5 - mobile anchor (with a threaded end and a nut) or a block with a gauging washer; 6 - hydraulic jack; 7 - welding regulator; 8 - welding transformer; 9 - current transformer; 10 - fixed anchor.

A number of requirements are set forth for the dressing material. It must be softened with rapid and momentary heating, and then set during cooling. In the hardened state the interlayer must ensure sufficiently high adhesion of the reinforcement with the concrete. It is necessary that the material of the interlayer not be destroyed during heating to 300-400°C, as well as that it be stable in the medium of the setting concrete and that it not age under the operating conditions of a reinforced-concrete structure. It is desirable also that the interlayer withstand autoclaving used during the steam curing of the concrete (high-speed setting of the concrete), and not only not cause the

reinforcing steel to corrode, but also serve as a protective coating.

The organosilicate materials obtained by preparing suspensions of finely dispersed silicates and oxides in the toluene solutions of polyorganosiloxanes satisfy the indicated requirements [2]. The results of the initial experiments on the use of interlayers made from organosilicate materials with the electrothermal method of stretching reinforcement in concrete were published earlier [3]. This report describes the technology of applying interlayers made from organosilicate materials to the reinforcement and the results of testing a number of prestressed reinforced-concrete articles. These articles were made using interlayers of organosilicate materials VN-30 (STU 30-2943-66) and S-2 (TU 17-67). Both the electrothermal and the electrothermomechanical methods of stretching the reinforcement to concrete were used.

Before applying the interlayers the reinforcement was first cleaned of rust and dirt (usually by shot blasting), and then it was degreased by acetone or by gasoline. The organosilicate materials were applied to the reinforcement, by brush or by dipping, in two or three layers to ensure sufficient coating continuity. The viscosity of the materials comprised 20-25 s per VZ-4; each layer of coating was dried in air at 10-20°C for 30-40 min. The overall thickness of the coating fluctuated within the limits of 0.3-1.0 mm.

When using reinforcement of periodic profile, because of the necessity of obtaining a large coating thickness organosilicate materials with a viscosity above 50 s per VZ-4 were used.

When using interlayers made from organosilicate materials the reinforcement must be equipped with end anchors designed to transmit the full amount of preliminary compression, since momentary electric

heating to 300-350°C does not ensure sufficient adhesive force of the reinforcement with the concrete through the interlayer. The arrangement of the end anchors, made in accordance with technical specifications, eliminates the influence on the operation of a structure under prolonged loads of the little-studied negative factors of aging, relaxation, creep of the interlayer, etc. After stretching of the reinforcement in the concrete, the end anchors, for protection from corrosion, are coated with the organosilicate material, and if necessary they are sealed.

The following were manufactured: concrete prisms 100 × 100 × 500 mm in size centrally reinforced by rods 12 mm in diameter made of smooth class A-III steel; cap plates $\frac{\text{PNS}}{6 \times 1.5}$·B, reinforced in the ribs by rods 14 mm in diameter made from class A-III steel; 100 × 200 × 1200 mm griders reinforced with bundles of high-strength steel wire Ø 5 × 3 mm. Prestressing in the prisms and the plates was created by the electrothermal method. Stretching of the reinforcement in the girders was accomplished by the electrothermmechanical method. Part of the girders had a curvilinear reinforcement arrangement (Fig. 2).

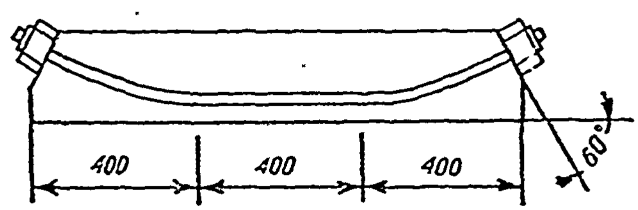

Fig. 2. Layout of curvilinear reinforcement in a girder.

A description of a number of the tested articles, the procedures for making them, and the obtained results are given in the table. In all cases accelerated setting of the concrete was accomplished by autoclaving; the cubic strength of the concrete comprised 250-350 kG/cm^2.

Procedure for making reinforced-concrete articles and the results of testing them.

Product	Reinforcement	Organosilicate material	Average interlayer thickness, mm	Interlayer drying regime		Regime of electric heating the reinforcement			Maximum temperature for heating the reinforcement, °C	Initial length of the reinforcement, mm	Controlled elongation of the reinforcement, mm	Force of adhesion of reinforcement with the concrete, kG/cm²
				Temperature, °C	Duration, h	Average current strength, A	Average intensity, V/m	Heating time, min				
Prism	Rod	C-2	0.3	60	20	650	3.7	3.3	220	650	2.7	14.8
	Ø 12 mm	C-2	0.6	20	48	650	3.7	3.3	220	650	2.7	10.6
		C-2	0.3	100	3	650	3.7	3.3	220	650	2.7	18.0
		VN-30	0.3	20	3 mos.	650	3.7	3.3	220	650	2.7	9.8
		VN-30	0.3	100	3	650	3.7	3.3	220	650	2.7	13.8
Plate	Rod Ø 14 mm	VN-30	1.0	20	24	685	3.0	4.5	225	6000	13.4	--
Girder*	Bundle of wire Ø 5×3 mm	VN-30	0.6	20	24	425	2.8	3.0	400	1200	7.0**	--
Girder***	The same	VN-30	0.6	20	24	425	2.9	3.0	400	1200	7.0	--

*Rectilinear arrangement of the reinforcement.
**Total elongation obtained by electric heating (6.0 mm) and the mechanical drawing of the reinforcement (1.0 mm).
***Curvilinear arrangement of the reinforcement.

The manufactured girders and plates were tested under a static load of 350 kG/m^2. In this case the gocd load-carrying capacity, the rigidity (1/1000-1/1700), and the resistance to cracks of the articles were found. The dependence between the load and the deformations, which was obtained during the testing of the girders with the wire reinforcement, is given in Fig. 3.

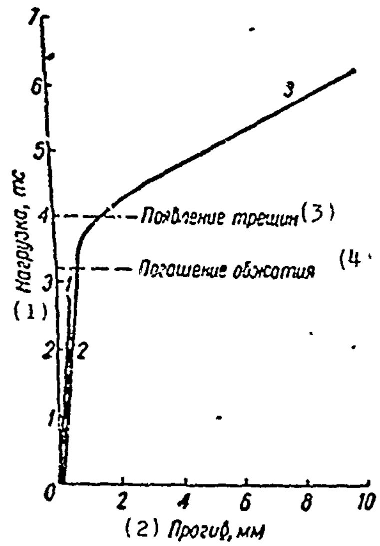

Fig. 3. Diagram of testing the girders with wire reinforcement: 1 - first loading; 2 - unloading; 3 - repeated loading.
KEY: (1) Load, t-f; (2) Sag, mm; (3) Appearance of cracks; (4) Quenching of compression.

The overall advantages of the electrothermal and the electrothermomechanical methods of producing prestressed reinforced concrete lie in the large savings of metal because of the elimination of power molds or stops and also in ensuring the capability of stretching curvilinear, diagonal and lateral reinforcement. However, the forms of interlayers proposed up to now (compositions based on sulfur [4] or phenolformaldehyde resins [5]) did not permit full use of the advantages of the above-indicated methods of prestressing reinforced-concrete structures by the electric heating of the reinforcement. The compositions with sulfur cause premature corrosion in the steel, while the phenolformaldehyde resins do not permit heating the reinforcement above 200-250°C and steam curing the concrete.

The use of organosilicate materials as interlayers makes it possible to stretch the reinforcement at a temperature of up to 300-400°C, which opens the possibility of using high-strength

steel of the high classes and producing reinforced-concrete articles according to plant technology with autoclaving. Furthermore, thanks to the shielding effect of the coatings made from organosilicate materials [6] reliable anticorrosion protection of the reinforcement from the different forms of corrosion is ensured.

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